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FISHERIES SCIENCE CENTER

HONOLULU

LA JOLLA

MONTEREY

TIBURON

REPORT OF ACTIVITIES

Second Quarter 1996

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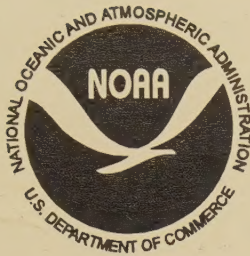
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ANTARCTIC ECOSYSTEM RESEARCH GROUP

La Jolla, California

Foraging Behavior and Movements of Large Rorqual Whales Studied

Fishery Biologist Roger Hewitt and Ocean Acoustic Engineer David Demer participated in the second year of a study to investigate the foraging ecology and dive behavior of large rorqual whales of the genus *Balaenoptera*, including fin whales (*B. physalus*) and blue whales (*B. musculus*). The two-year project was funded by the Office of Naval Research, and the principal investigator was Donald Croll (University of California at Santa Cruz).

During the study's field effort, Hewitt participated in several cruises of short duration over a one-month period in a bay between La Paz and Loreto, Mexico. During that time, recoverable electronic devices were deployed by crossbow onto rorqual whales in known foraging areas. These devices contained a microprocessor-controlled time-depth-temperature data recorder (TDR), a VHF radio transmitter to allow tracking of the tagged animal for extended periods, and a radio-activated release mechanism. The tagged animals were tracked by ship while researchers concurrently measured prey distribution in the water column using a high-frequency hydroacoustic system, and water column temperature using a portable conductivity-temperature-depth (CTD) sensor. Acoustic signal emissions by the tracked whales and ambient low-frequency sound levels were measured using three-hydrophone arrays suspended from buoys.

Hewitt collected prey distribution data in relation to diving behavior and movements of tagged whales. The horizontal and vertical distributions of prey were monitored using a portable SIMRAD hydroacoustic system with 38 and 200 kHz hull-mounted transducers. In conjunction with acoustic operations, prey concentrations were sampled with a 1/2-meter ring net. The net samples were measured and species were determined.

The investigations were very successful, and following data analysis, Hewitt and Demer were able to map the prey field of the entire bay. Net samples and whale fecal samples confirmed the species composition of the prey field to be primarily the euphausiid *Nyctiphanes simplex*. Four areas of high

euphausiid concentrations were identified in the bay; these prey patches were present at a depth of 100-150 m throughout the month-long study. Six tagged whales were tracked and found consistently foraging in these four areas. TDR records of these animals also revealed the depth and diving pattern for each foraging dive. Hewitt and Demer will participate in similar studies of rorqual whales in Monterey Bay in the late summer. (J. Martin, 619-546-5600)

COASTAL FISHERIES RESOURCES DIVISION

La Jolla, California

Book Completed on the Early Stages of Fishes of the California Current Region

Division scientists recently completed a book entitled *The Early Stages of Fishes in the California Current Region*. This comprehensive guide to the eggs, larvae, and juvenile fishes of the California Current and adjoining regions includes coastal marine fishes and oceanic, midwater, and deep-water benthic species. The study was funded in part by the Interior Department's Minerals Management Service. The area covered ranges from the Pacific Northwest to Cabo San Lucas, Mexico, and seaward to the outer margin of the California Current. This monograph is the culmination of six years of work by division staff. Principal authors are SWFSC scientists William Watson, H. G. Moser (editor), David A. Ambrose, Sharon R. Charter, and Elaine M. Sandknop.

The volume includes chapters on 158 families of fishes in 25 orders and treats a total of 586 species (467 with full descriptions and 119 summarized in the chapter introductions; the early stages of about 27% of the species are described for the first time). In the chapter introductions, information on taxonomy, zoogeography, morphology and ecology of adults, spawning modes, and general features of the eggs and larvae is summarized, and tables listing fin-ray counts and other meristic features useful in species identification are included. The book contains more than 2,500 illustrations of eggs, larvae, and juveniles, including 1,170 original, previously unpublished illustrations by Nancy Arthur, Barbara Sumida MacCall, George Mattson, Henry Orr, Mary Vona, Robert Walker, and William Watson. Most of the original unpublished illustrations were pro-

duced as a result of the Minerals Management Service contract. The book contains 1,505 pages, 167 tables in the text, and 925 morphometric and meristic tables in the species descriptions. Scientific and common names are indexed and an extensive bibliography is presented with 1,375 titles.

The extensive research advances made during this project greatly expanded knowledge of the early stages of fishes. Scientists can now identify the larval and juvenile stages of most fish species that occur in the California Current region. The book's broad taxonomic coverage extends its usefulness beyond the California Current region and makes it a fundamental resource for scientists studying fishes in all oceans. (H. G. Moser, 619-546-7129)

MARINE MAMMAL DIVISION

La Jolla, California

The SWFSC Hosts an International Whaling Commission Symposium and Workshop on Climate Change and Cetaceans

The National Marine Fisheries Service (NMFS), Southwest Fisheries Science Center (SWFSC) hosted the International Whaling Commission (IWC) Symposium and Workshop on Climate Change and Cetaceans, March 25-30, 1996, in Kahuku, Hawaii. The symposium and workshop were a unique opportunity to bring together government scientists, academics, non-government environmental organization scientists, students, and the general public to discuss environmental effects from different physical and biological perspectives. This was the second in a series of special meetings convened by the IWC on potential environmental effects on cetacean populations.

The two-day symposium was focused on the processes related to global climate change and how these processes may affect cetacean populations. Global warming, ozone depletion, and their effects on distribution and abundance of cetaceans were discussed.

At the four-day workshop, participants presented information from ongoing and completed research programs. Results of a recent report by the Intergovernmental Panel on Climate Change were considered and information gaps relating to physical and biological linkages and implications for the

IWC were addressed. The participants' main tasks were to determine which predicted climatic changes might impact cetacean populations, the likely consequences of such changes given current knowledge, and what research would improve the understanding of the consequences of climate change on cetaceans.

The group generated a preliminary report combining information presented during the symposium and results from the workshop. The report was presented to the IWC Scientific Committee in June 1996 and provides the framework for future cooperative research programs on the effects of environmental changes on cetaceans. (S. B. Reilly and J. Sisson, 619-546-7064)

Division Scientists Contribute to the IWC Annual Meeting Held in Aberdeen, Scotland

The 48th Annual Meeting of the IWC Scientific Committee was held in Aberdeen, Scotland, June 5-17, 1996, under the chairmanship of Stephen Reilly, leader of the SWFSC's Cetacean Ecology Program. Marine Mammal Division scientists prepared reports and provided data which the Scientific Committee utilized throughout the meetings, and they participated in sub-committee meetings and working groups. Five sub-committees discussed management procedures, Southern Hemisphere baleen whales, stocks subject to aboriginal subsistence whaling, North Pacific Bryde's whales, and small cetaceans. Working group topics included whale sanctuaries, whale watching, and future goals and priorities for the IWC. The Scientific Committee also discussed cooperation with other organizations, environmental concerns (including the IWC Climate Change Symposium and Workshop and the effects of the proposed Mexican salt-works on eastern Pacific gray whales), the IWC's Revised Management Plan, scientific permits, and research proposals.

A report of the meeting can be obtained from Greg Donovan, International Whaling Commission, The Red House, Station Road, Histon, Cambridge CB44NP, England. The data, reports, and documents submitted by the Marine Mammal Division of the SWFSC are summarized below.

Aboriginal Subsistence Whaling

Eastern Pacific Gray Whale

Wayne Perryman, leader of the division's Photogrammetry Program, Meghan Donahue, contractor,

and Stephen Reilly provided results of a shore-based survey to estimate the number of northward-migrating gray whale calves passing Pt. Piedras Blancas, California, between mid-March and late May, 1994 and 1995 (IWC SC/48/AS4). The 1994 estimate did not differ significantly from estimates for 1980 and 1981 and the 1995 estimate was significantly lower than all of these estimates. (W. Perryman 619-546-7014)

Western Pacific (Okhotsk Sea) Gray and Bowhead Whales

The large whale populations in the Okhotsk Sea are the least known complex of all the world's whales, yet gray, bowhead, and right whales from this area are considered among the world's most endangered whale stocks. Commercial whaling reduced populations of large whales in the Okhotsk Sea considerably. Current populations face threats from offshore oil and gas development and from tidal electric stations on or near the feeding grounds. Division Chief Robert Brownell presented results from a cooperative long-term study he initiated last year along with other U.S. scientists, Wildlife Biologist Robert Pitman, SWFSC, and Richard LeDuc, Scripps Institution of Oceanography; Drs. A.M. Burdin and A.A. Berzin from Kamchatka Institute of Ecology and Nature Management, Russia; and Dr. S.A. Blokhin from the Pacific Research Institute of Fisheries and Oceanography, Russia (IWC/SC/48/AS21). These long-term studies are needed to obtain valuable information which will lead to a better understanding of the status and distribution of both populations in order to minimize human disturbance of these extremely endangered species. (R. Brownell, 619-546-7165)

Management

Risk Assessment and Management Models for Cetaceans

Research Fishery Biologist Barbara Taylor presented three papers reviewing some of the current thinking for small and large cetacean management. The first paper, coauthored with SWFSC Population Identity Program Leader Andrew Dizon, described risks of global extinction and of regional depletion or extinction leading to a reduction or fragmentation of range (IWC SC/48/Mg2). In the second paper, coauthored with Paul Wade, Office of Protected Resources, Douglas DeMaster, National Marine Mammal Laboratory, and Jay Barlow, Coastal Marine Mammal Program leader, Taylor identified a

number of inadequacies of existing models used to manage marine mammals (IWC SC/48/Mg8). Work in progress that addresses the estimation of dispersal rates using genetic data was discussed in a third paper (IWC SC/48/O13). (B. Taylor, 619-546-5620)

North Pacific Whales

Historical Whaling Data

National Resource Council (NRC) Fellow Phillip Clapham combined efforts with Stephen Leatherwood, Ocean Park Conservation Foundation, Hong Kong, Isidore Szczepaniak, California Academy of Sciences, and Robert Brownell to review logbook data from California whaling stations at Moss Landing (1919-22 and 1924) and Trinidad (1920, 1922-26) (IWC SC/48/NP2). The seasonality and the sex ratio of the take, stomach contents, reproductive data, and length data for all species were investigated. (R. Brownell, 619-546-7165)

Whale Meat Identification

Jeffrey Bada, Scripps Institution of Oceanography, and Robert Brownell investigated the possibility of using bomb radiocarbon dating techniques to estimate the year of harvest and to compare these results with the time of harvest deduced from other available data (IWC SC/48/NP25). For this study, a radiocarbon activity reading of a sample of Bryde's whale meat obtained from Russian officials corresponded to the time period of maximum bomb radiocarbon activity measured in tropical ocean surface waters. The peak in oceanic bomb radiocarbon activity occurred during the years 1972-75. Additional data indicated this whale was harvested during the period between 1976 and 1979 and the meat was of Taiwanese rather than Russian origin. (R. Brownell, 619-546-7165)

Other

1995 Indian Ocean Cetacean Survey

NRC Fellow Lisa Ballance, Robert Pitman, and Stephen Reilly summarized results of a cetacean survey conducted in the western tropical Indian Ocean during 105 sea days, from March 21 to July 25, 1995 (IWC SC/48/O8). They recorded information from 589 cetacean sightings consisting of a minimum of 21 species. Significant findings included 1) highly localized distribution of blue whales, 2) high abundance of sperm whale sightings relative to other species, 3) field identification of a distinct form of common dolphin, also with a

highly localized distribution, 4) sightings of mixed aggregations of spotted and spinner dolphins, yellowfin tuna, and seabirds. (L. Ballance 619-546-7173)

Life History Information of Cetaceans Incidentally Killed in California Drift-Net and Set-Net Fishery Between 1990-1995

Fishery Biologists Susan Chivers, Kelly Robertson, and Michael Henshaw identified 16 cetacean species among the observed incidental kill in drift-net and set-net fisheries operating off the coast of California (IWC SC/48/O 9). They demonstrated the value of confirming species identification using molecular genetic techniques. Results also revealed that these fisheries incidentally kill a wide range of age and length classes. (S. Chivers, 619-546-7093)

Dried Blood on Fishery Observer Records Could Provide DNA for Genetic Analyses

For nearly three decades biological technicians have accompanied tuna fishing vessels in the eastern tropical Pacific to collect information on incidental kill of small cetaceans. Lori Eggert, graduate student from the University of California at San Diego, and SWFSC scientists Christi Lux, Greg O'Corry-Crowe, and Andy Dizon examined observer data records stained with blood, presumably from the handling and dissection of by-caught animals (IWC SC/48/O 10). They investigated whether these blood stains represented a source of DNA that would permit molecular genetic analysis of a number of delphinid species. Thus, blood-stained data sheets may represent a previously untapped source of genetic information on individual animals previously unavailable to this type of investigation. The ability to extract useable DNA from records as much as 28 years old may provide a temporal as well as a spatial dimension to many genetic studies. These investigators found the deliberate marking of data sheets in this way could provide independent tests of species identity. (A. Dizon, 619-546-7089)

Aleutian Island Cetacean Survey

During July and August 1994, the SWFSC conducted a two-part marine mammal survey off the coasts of Oregon and Washington, and along the Aleutian Islands, Alaska. The study was a collaborative effort between the NMFS, U.S. Navy, Pacific Marine Environmental Laboratory, Scripps Institution of Oceanography, Oregon State University, and University of Washington. Blue and humpback

whales were of particular interest, but sighting information was recorded for all cetacean species encountered. Acoustic recordings, tissue samples, and photographs of individual whales were opportunistically collected. Biologist Karin Forney and Robert Brownell prepared a report of the Aleutian Islands Survey (IWC SC/48/011). (K. Forney, 619-546-7171)

Molecular Phylogeny of the Bryde's /Sei Whale Complex: Separate Species Status for the Pygmy Bryde's Form?

Molecular genetic analyses were performed to clarify the intraspecific structure of the Bryde's whale (*Balaenoptera edeni*), especially the status of the so-called pygmy Bryde's whale (IWC SC/48/O 10). Results were consistent with the idea that the pygmy Bryde's whale is an additional species within the Bryde's/sei complex rather than a subspecies or subpopulation of the Bryde's whale taxon. (A. Dizon, 619-546-7089)

Small Cetaceans

California Harbor Porpoise

The abundance of harbor porpoise (*Phocoena phocoena*) in nearshore waters off central California was recently reported to have declined between 1986 and 1993 based on aerial surveys designed to monitor the relative abundance of this species. An eighth aerial survey conducted in 1995 completed a 10-year study for this population. Karin Forney presented an updated trend analysis for the ten years 1986-95, and investigated one possible explanation for the decline, relating to distributional shifts of this population in relation to oceanographic changes (IWC SC/48/SM5). A power analysis was performed to evaluate the likelihood of detecting trends in the 10-year time series, indicating that power is similar to the values predicted earlier but overall is still too low to reliably detect small changes in abundance. Compared to results obtained for the 1986-93 time series, encounter rates were higher in 1995, and the estimated overall rate of decline in relative abundance changed from 9.4% to 5.9% per year. (K. Forney, 619-546-7171)

Pacific White-Sided Dolphin

The Scientific Committee undertook a global review of the genus *Lagenorhynchus* during this year's meeting. Sean Costa, Christi Lux, and Andrew Dizon contributed to this review by providing a genetic analysis of 116 tissue samples from Pacific

white-sided dolphin (*L. obliquidens*) (IWC SC/48/SM6). Resolving the population structure of the abundant, mobile, continuously distributed Pacific white-sided dolphin presents particular challenges for molecular genetics. However, given sufficient samples distributed broadly across the species range, examination of the hypervariable portion of the mitochondrial DNA control region could yield some insights.

A possible population structure scenario for Pacific white-sided dolphins in the eastern Pacific Ocean is that a unique clade of haplotypes developed in isolation off Baja California; secondary contact occurred, and the limited historical or contemporaneous gene flow produced the observed haplotypic distributions within the Baja California and California, Oregon, and Washington strata. Because haplotypes characteristic of the southern strata occurred in the northern waters more often than northern haplotypes appeared in the southern waters, the dispersal may be biased northward. (A. Dizon, 619-546-7089)

Cetacean Mortality in California Gillnet Fisheries

Statistician Fred Julian reported on the number of cetaceans killed in two California gillnet fisheries, the swordfish and shark driftnet fishery and the halibut/angel shark set-net fishery, estimated during 1995 (IWC SC/48/SM11). His estimates were based on observations made by NMFS biological technicians aboard commercial fishing vessels. The estimated mortality of marine mammals along with coefficient of variation (CV) and number of observed entanglements during 1995 (in parentheses) for the driftnet fishery are: 68 (0.39, 11) long-beaked common dolphins; 190 (0.30, 31) short-beaked common dolphins; 37 (0.57, 6) Risso's dolphins; 55 (0.59, 9) northern right whale dolphins; 6 (0.91, 1) Pacific white-sided dolphins; 6 (0.92, 1) killer whales; 6 (0.92, 1) Dall's porpoise; and 31 (0.40, 6) Cuvier's beaked whales. One Cuvier's beaked whale was observed released alive during 1995. Total estimated entanglement (lethal and non-lethal) was 37 (CV=0.36) animals for this species. For the set-net fishery, there were an estimated 25 (0.24, 0) harbor porpoise killed. The overall coverage rate for the driftnet fishery during 1995 was 16.3%. The set-net fishery has not been observed since July 1994; consequently, estimates of harbor porpoise mortality were based on observations from July 1990 to July 1994. Entanglement and mortality estimation are used to monitor the magnitude of cetacean and fishery interaction and to assist in fishery manage-

ment (for example, stock assessments). (F. Julian, 619-546-7171)

Mitochondrial DNA Sequence Analysis Indicates the Need for Revision of the Genus *Tursiops*

Bottlenose dolphins, genus *Tursiops*, are currently considered one species (*T. truncatus* Montagu), but numerous nominal species exist and phylogenetic relationships within the genus are unclear. Pronounced geographic variation, particularly between inshore and offshore animals, has contributed to uncertainties regarding stock structure and taxonomy of the genus. To provide context for an intraspecific analysis of bottlenose dolphins, Richard LeDuc and Barbara Curry used complete mitochondrial DNA (mtDNA) cytochrome B (cyt B) sequences (1140 bp) to examine *Tursiops*' interrelationships with the closely related genera *Stenella*, *Delphinus*, and *Lagenodelphis* (IWC SC/48/SM27). Results of control region sequence analyses indicated species-level differences between all offshore animals sampled and inshore animals from the western North Atlantic and Gulf of Mexico. The results also suggested most of the genetic variation within *Tursiops* is contained within offshore populations. (B. Curry, 619-546-7094)

Abundance and Mortality Estimation of Cetaceans Within the Exclusive Economic Zones of the Eastern Tropical Pacific Ocean

Tim Gerrodette, Stock Assessment Program leader, and Daniel Palacios, a Colombian visiting scientist, defined seven study areas based on the Exclusive Economic Zone Pacific waters of México, Guatemala, El Salvador, Honduras, Nicaragua, Costa Rica, Panamá, Colombia, and Ecuador. Based on extensive surveys conducted between 1986 and 1993, the abundances of the most common cetaceans were estimated for each area (IWC SC/48/SM35). The problem of cetacean incidental mortality in artisanal gillnets is relatively recent along the Pacific coast of Central and South America, where small-scale and subsistence fisheries operate. Based on limited available information on numbers of fishing boats, small cetacean capture rates, net and mesh sizes, and intensity of fishing effort, numbers of small cetaceans of the genera *Stenella*, *Delphinus*, *Globicephala*, and *Tursiops* killed in artisanal gillnet fisheries were estimated for the zones of Panama, Costa Rica, and Ecuador (IWC SC/48/SM36). Mortality rates were estimated to be 5-10% per year of estimated population sizes, rates that are unlikely to be sustainable. (T. Gerrodette, 619-546-7131)

HONOLULU LABORATORY

Honolulu, Hawaii

PROTECTED SPECIES INVESTIGATION

Hawaiian Monk Seal Pup Born on Oahu

On April 6, 1996, a Hawaiian monk seal (*Monachus schauinslandi*) pup was born on Oahu, only the second recorded birth on the island. The pup's mother, recognizable by a distinctive scar pattern, previously gave birth on Oahu in 1991. The recent birth occurred at a remote beach on the Kaneohe Marine Corps Base, Hawaii, and was reported to the Honolulu Laboratory by staff of the base's Environmental Services Branch, which closed the beach and cordoned off the area.

The pup, a male, nursed from its mother without incident for 53 days, well in excess of the 39-day mean for seals in the Northwestern Hawaiian Islands. The mother departed on May 28, and the pup was measured and tagged by Honolulu Laboratory and MCBH personnel on May 30.

Marine Mammal Research Program scientists considered several options for the pup, including relocation to the Northwestern Hawaiian Islands or to another site within the main islands. Ultimately, however, the scientists decided to leave the pup at the remote site. Flyers warning of the pup's presence were prepared and distributed to dive shops, yacht clubs, and other centers of recreational aquatics in the Kaneohe area. (J. Henderson, 808-943-1225)

FISH BIOLOGY AND ECOLOGY INVESTIGATION

Activity Reports Presented at Annual Tuna Conference

The Honolulu Laboratory was well represented at the 47th Annual Tuna Conference in Lake Arrowhead, California, May 20-23, 1996. Honolulu Laboratory Director Michael Laurs convened a conference session on "Distribution, Movements, and the Environment," which included four presentations by Honolulu Laboratory staff and collaborators from the Joint Institute for Marine and Atmospheric Research (JIMAR, University of Hawaii).

Fishery Biologist Chris Boggs reported on his work with John Gunn, CSIRO Division of Fisheries, Tasmania, "External attachment techniques for archival

tags." Boggs explained that a rapid method for attaching archival tags without close handling is important in tagging broadbill swordfish (*Xiphias gladius*) in the North Pacific. New pop-up, satellite-transmitting archival tags (PSTATs) will be used to record light, depth, and temperature and provide information of unprecedented quality on fish migration and habitat use. Tests comparing the force required to pull out several types of intramuscular tag anchors indicated swordfish muscle was less resistant than that of tuna and marlin and therefore more conducive to tag shedding. Boggs reported how a stainless steel tag anchor with a large surface area designed for use on swordfish was tested using dummy PSTATs attached to southern bluefin tuna (*Thunnus maccoyii*) in South Australia.

JIMAR Fishery Biologist Keith Bigelow presented a report, "Examination of longline fishing strategies and performance using cluster analysis and general additive models (GAMs)," on his work with Fishery Biologist Xi He (JIMAR) and Boggs. Bigelow reported the usefulness of catch-per-unit-effort (CPUE) as a relative index of abundance was increased by using cluster analysis to quantitatively classify longline set types based on species composition of the catches. Three clusters comprised ~80% of the total sets, and the catch compositions suggested targeting for either broadbill swordfish or bigeye tuna (*T. obesus*). GAMs were used to model the trend in swordfish CPUE of the swordfish clusters as a function of environmental conditions. The predominant explanatory components of the GAM included sea surface temperature (SST), an SST frontal index, and the joint effect of latitude and month of fishing. Higher CPUE occurs more frequently in longline sets in cooler water (15-19°C) and in the vicinity of SST fronts than in other areas.

Fishery Biologist Jeff Polovina presented results of his work with Fishery Biologist Don Kobayashi, "Ocean circulation models as a tool to provide oceanographic data needed to achieve sustainable pelagic fisheries." Polovina described output from these models including oceanographic data with both high spatial and temporal resolution with basin-scale coverage. This unique aspect of model output is proving valuable in investigating a range of issues, from impacts of climate variation on ocean circulation to the dynamics of fronts. Examples of output from the Semtner-Chervin ocean circulation model with application to pelagic fisheries research in the North Pacific were also presented.

Fishery Biologist Richard Brill (JIMAR) described his collaborative work with Barbara Block of Stanford University, and others from the Honolulu Laboratory and JIMAR. The presentation was entitled "Horizon-

tal and vertical movements of adult yellowfin tuna (*T. albacares*) near the Hawaiian Islands observed by acoustic telemetry." Brill described how five adult yellowfin tuna (64-93 kg, 148-167 cm fork length) were tracked off the Kona coast of the island of Hawaii during August 1995 while researchers simultaneously gathered data on water temperature, oxygen levels, and oceanic currents. During over 8 days of tracking, the fish remained within 14 nmi of the Kona coast, moving beyond 10 nmi from the coast on only three occasions. The tight association of the adult yellowfin tuna with the coastline during the 2-week study period contrasted with the much more directed offshore movement of blue marlin and striped marlin previously tracked off the Kona coast.

JIMAR Fishery Biologist Keith Bigelow contributed to a poster session with a presentation on his work with Bob Nishimoto (NMFS La Jolla), Michael Laurs, and Fishery Biologist Jerry Wetherall entitled "Validated age and growth models for North Pacific albacore tuna." Validated length-at-age models for albacore of 35-127 cm fork length were developed from otolith microstructure to allow interpretation of catch-at-age compositions. Growth models based on scanning-electron-microscopy of otoliths were consistent with growth calculated from an updated tag-recapture model.

Fishery Biologist Xi He presented results of his work on "Spatial, temporal, and gear-related bycatch of blue shark (*Prionace glauca*) by the Hawaii-based longline fishery." He described how bycatch and total discards of blue shark were estimated using both logbook and observer data. About 500,000 blue shark were estimated to have been caught between 1991 and August 1995 (only a few more than were reported in the logbooks) representing over 1/3 of all fish caught. The highest catch rate for blue shark was found in one subgroup of longline sets which targeted swordfish between latitude 35 and 45°N during September and October. Another group of longline sets targeting swordfish had low blue shark catch rates and was characterized by the use of fewer light sticks. Longline sets targeting tuna also had low catch rates for blue shark. (C. Boggs, 808-943-1222)

FISHERY MANAGEMENT AND PERFORMANCE INVESTIGATION

Scientists from American Samoa Complete Ageing Techniques Training

For 15 years, the Western Pacific Fishery Information Network (WPacFIN) office of the NMFS Honolulu Laboratory has coordinated and developed programs to monitor and manage fishery resources under U.S. jurisdiction in the central and western

Pacific Ocean. The cooperative programs include local government and federal fisheries agencies in Hawaii, American Samoa, Guam, and the Northern Mariana Islands. Recently, two fishery scientists from the American Samoa Department of Marine and Wildlife Resources received training in techniques of ageing fishes. The ageing of commercially valuable species will be an integral part of the department's ongoing insular stock assessment program of deepwater bottomfishes around the islands of Manu'a and Tutuila in American Samoa.

The two scientists worked with Jeffrey D. Sampaga and Happy A. Williams, fishery research assistants with the Swordfish Life History Investigation, from May 13-17, 1996. The comprehensive training included a synopsis of the chemical physiology of the otoliths, an explanation of the significance of daily growth increments and seasonal marks, and a general description of the inner ear and microstructures of the sagittal otolith. Sampaga and Williams demonstrated sectional and whole mounting techniques for surface reading. Samples were later read under a compound microscope with transmitted light. The visitors experienced hands-on training in preparing and reading otoliths from *Lethrinus* sp. and *Etelis* sp. caught in American Samoa. (B. Kikkawa, 808-943-1215)

PACIFIC FISHERIES ENVIRONMENTAL GROUP

Pacific Grove, California

Relationship of Biodiversity and Marine Fisheries Described

A recent issue of *Oceanography* magazine (Vol. 9, issue 1) featured an article by PFEG Oceanographer George Boehlert which described the relationship of biodiversity and marine fisheries. The special *Oceanography* issue, which was dedicated to marine biological diversity and edited by former National Oceanic and Atmospheric Administration (NOAA) Chief Scientist Kathryn Sullivan, commemorated 25 years of science and service by NOAA.

The importance of the relationship between biodiversity and marine fisheries was affirmed in a recent National Research Council workshop report which identified fisheries operations as one of the major anthropogenic effects on marine biodiversity. As fisheries develop, the "fishing up" process follows a similar sequence with an initial expansion of the geographic range of the fishery; landings of the most

desirable species increase, peak, and then decrease, followed by changes in the species composition of the landings. The total catch of world marine fisheries has not markedly increased in recent years, but the distribution of catch has changed. Since 1970, the highest rates of increase have been for krill, cephalopods, and tunas, as opposed to coastal species. This suggests that the "fishing up" process is occurring on a worldwide basis.

Marine fisheries cause changes at three levels of organization of biodiversity. At the genetic level, fisheries increase mortality and act as an agent of directional selection, affecting age distribution, age and length at maturity, and growth rates, among other life history characteristics. Genetic effects induced by marine aquaculture and ocean ranching are a particular concern where fish husbandry and large-scale releases decrease genetic diversity, and select for particular traits that may not be best suited to long-term environmental variability. At the species diversity level, fisheries affect species composition in fished ecosystems and consequently interactions among fished species and their prey. Direct effects of fishing on species diversity are caused by removals of target species, by-catch of unwanted species, physical disturbance, and discards. Fisheries often begin on large predators and decreased populations may lead to increased abundance of prey species, which may themselves become subject to fisheries. Long-term fisheries can lead to system dominance by species with certain life history characteristics (early maturation, small maximum size reached rapidly, high fecundity, and relatively short longevity); these characteristics describe small pelagic fishes, which often become major components of mature fisheries. Other components of the system are also affected; for example, trophic inputs from fishery discards in the North Sea have caused long-term changes in the abundance and species composition of sea birds. Finally, through effects of by-catch, habitat alteration, and altered energy flow, fisheries impact the diversity of marine habitats and the function of ecosystems. Although several instances of fisheries-mediated habitat destruction have been documented, ecosystem-level biodiversity changes are often the most poorly understood. Ecosystem models have potential applications in evaluation of these changes.

Biodiversity is an important issue, not only to protected resources and habitat but also to sustainable fisheries, and should be of growing concern to fishery managers. While many of the effects of marine fisheries on biodiversity are obvious, evidence is circumstantial or lacking for some of the potentially most devastating effects. On the time scale of decades, however, fisheries can change ge-

netic, species, and ecosystem diversity from levels achieved over millions of years through natural selection. There is little doubt that such changes in biodiversity will decrease the resiliency of species, communities, and ecosystems to respond to natural perturbations that occur on longer time scales. Understanding how fisheries and other anthropogenic changes affect marine biodiversity is necessary to develop strategies to ameliorate future ecological changes. Fisheries have major impacts upon marine biodiversity; the long-term sustainability of these fisheries may be dependent upon the very diversity being changed. (G. Boehlert, 408-648-8447)

Patterns of Decadal Environmental Variability in Northeast Pacific Presented and Discussed at Salmon Workshop

Many West Coast salmon stocks have experienced dramatic population declines in recent years. Stock allocations are a point of contention; Pacific Northwest fisheries have been closed and several salmon runs are now listed as threatened or endangered under the Endangered Species Act. This has heightened interest in studying the salmon's complex life history, varied habitats, and numerous prey and predator linkages, to enhance understanding of the factors driving population fluctuations of these economically important species.

The relationship between ocean survival and variations in environmental conditions is one particular facet of salmon life history which has been ignored until recent years. NMFS and Oregon State University convened a workshop on estuarine and ocean survival of Pacific salmonids in March 1996 in Newport, Oregon. The workshop brought together almost 100 oceanographers, fisheries scientists, ecologists, and managers to synthesize information relating physical, chemical, and biological conditions and factors to salmon survival, and to identify questions, hypotheses, and research strategies to improve understanding of how estuarine and ocean habitats affect survival.

PFEG Oceanographer Frank Schwing was an invited speaker and addressed the attendees on patterns of decadal variability in the northeast Pacific and effects on pelagic stocks. The focus of the talk was to describe decadal-scale differences in the spatial texture of the northeast Pacific, to provide a base from which to evaluate the effect of climate change on the area's ecosystems and particularly on salmonid populations and fisheries. An extended abstract of this presentation will be published as a NOAA Technical Memorandum.

Speakers at this workshop clearly demonstrated the highly variable nature of the northeast Pacific environment in time and space, and argued against assuming climate change is constant or can be represented by a record from a single location. The distinct latitudinal regionalization and cross-shelf variability of wind and SST fields have key implications for ecosystem studies as well as fisheries management, particularly for salmonids, which have latitudinally distinct stocks. These results stimulated considerable discussion during the oral presentation sessions and the subsequent working groups. The participants agreed ocean conditions and variability play a much more critical role in salmon survival than traditionally accounted for in conceptual models. The general consensus was, analysis of historical data demonstrates the need for a long-term interdisciplinary ocean monitoring program.

The analysis of ocean variables led many to consider that the mechanisms leading to such fluctuations may account for variability in other factors (for example, precipitation) that could determine interannual changes in survival. The salmon's complex life history, combined with the numerous physical forces affecting distribution, migration, growth, and mortality, make understanding salmon survival an extremely complicated issue. However, freshwater survival is not the exclusive factor in determining the successful return to spawning streams of smolts as adults, and estuarine and ocean variability, related to many different processes and forces on a number of time and space scales, may well be the critical factors in controlling fluctuations in salmon populations, specifically the long-term declines in the size of the Pacific Northwest fisheries. (F. Schwing, 408-648-9034)

Demand Increases for PFEG Data Products and Services

PFEG generates a series of products and fills a number of requests for customized environmental data. Indices of upwelling and a series of sea surface temperature (SST) maps have been produced and distributed each month for almost 30 years. Upwelling and SST values are generated by PFEG from wind analyses and ship observations available only from the U.S. Navy Fleet Numerical Meteorology and Oceanography Center (FNMOC) in Monterey, California. Increased demand for its data services has prompted PFEG towards automated production and electronic distribution. A summary of PFEG products is given here.

Monthly Upwelling Indices and West Coast SST Maps--Products are sent to 56 researchers and managers around the world (Figure 1). The upwelling indices are calculated for 15 standard

points along the West Coast each month (Internet, <http://www.pfeg.noaa.gov/products/upwell.html>). Customized indices are also tailored to areas of special interest to researchers. A NOAA Technical Memorandum summarizing 50 years of upwelling indices will be published later this year.

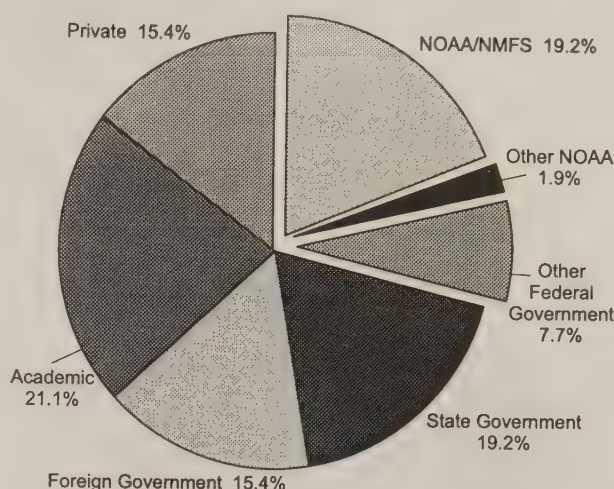


Figure 1. Distribution of monthly products.

SST maps derived from FNMOC surface marine observations collected in near real time are unique in the detailed information provided. Two overlapping maps cover the West Coast from Baja California to Alaska. Each 1° square contains a mean monthly temperature, anomaly, and the number of ship observations used. The monthly products are usually available during the last week of the month.

Special Requests and Data Archives--Since 1984, PFEG data managers have filled more than 350 special data requests which have contributed substantially to many important publications in oceanography and fisheries science (Figures 2 and 3). The number of requests being received is at an all-time high. Many special requests are for various wind indices derived from the FNMOC analyzed pressure fields. Time series of north and east wind components, wind speed cubed, and Ekman transport for special points and areas are frequently requested. PFEG also archives and distributes data obtained from research cruises and shore stations, instrumented buoys, and satellites. PFEG maintains a local archive of sorted AVHRR images from the NOAA/NMFS Coastwatch Program at the Southwest Fisheries Science Center. Due to frequent requests and local research interests, PFEG also maintains a data archive of buoy observations from the National Data Buoy Center.

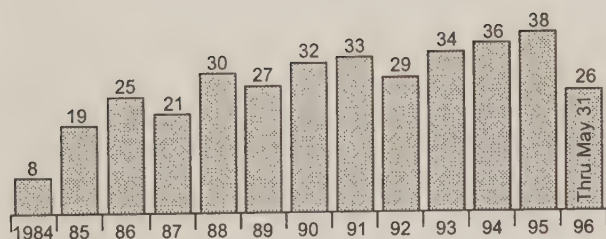


Figure 2. Number of special requests since 1984.

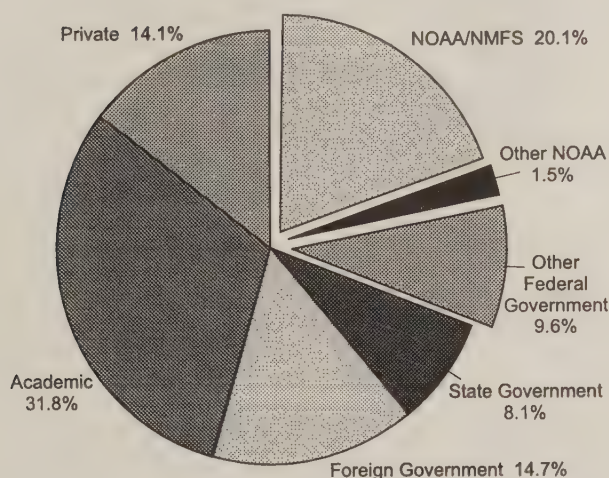


Figure 3. Sources of special requests.

Electronic Distribution of Products--PFEG has had Internet access since fall 1995, and users of its products are gradually converting to electronic data product acquisition. Electronic delivery is not only faster but eliminates the need for recipients to enter the data manually into their databases. Product preparation time, mail handling, and postage costs for PFEG are also decreased. The monthly upwelling indices and anomalies are now routinely sent as e-mail attachments. Larger data sets, such as the approximately 300,000 surface ship reports sent monthly to the Inter-American Tropical Tuna Commission (La Jolla, California) and to NOAA's Climate Data Center (Boulder, Colorado), are sent by file transfer protocol. In the future, monthly data files and graphics will be available on the PFEG Web site at <http://www.pfeg.noaa.gov/> and users will be able to generate their own special requests from an interactive style Web page. This will increase product and archive availability and reduce PFEG labor costs.

Individuals interested in receiving PFEG monthly products or modernizing their delivery to electronic form may contact John Steger; special data requests may be made to Jerry Norton.

(J. Steger, 408-648-9035; email: products@pfeg.noaa.gov; J. Norton, 408-648-9031; email: requests@pfeg.noaa.gov)

PELAGIC FISHERIES RESOURCES DIVISION

La Jolla, California

Angler Survey and Billfish Tagging Program Results Published

Analyses of the *International Billfish Angling Survey for 1994* and the *1995 Cooperative Marine Game Fish Tagging Program* were completed in March. Results were published in the *1996 Billfish Newsletter*, an annual publication produced by the division. The newsletter emphasizes recreational billfish angling and conservation of billfish resources in the Pacific and Indian Oceans and is provided as a service to the international angling community. The data presented are the result of the cooperation of billfish anglers, sport fishing clubs, and agencies affiliated with the SWFSC.

The *Billfish Newsletter* also is available on the Internet at <http://swfsc.ucsd.edu>.

Results of the *Billfish Angler Survey for 1994*

Angler Survey -- The *Billfish Angler Survey* was initiated in 1969 to provide estimates of billfish angling activity (effort and catch) throughout the Pacific and Indian Oceans.

Billfish anglers responding to the *Billfish Angler Survey* for the 1994 fishing year reported catching 2,671 billfish during 6,589 days of fishing in the Pacific and Indian Oceans. This is a decrease of 23% from the number of angler-days reported for 1993. The overall success rate was 0.41 billfish per angler day or 2.47 days fishing to catch a billfish. This is similar to the 1990 to 1993 catch rates of 0.42, 0.43, 0.57 and 0.40 billfish per day.

The numbers of billfish reported caught by anglers are presented in Table 1. This included 587 Pacific blue marlin, 136 black marlin, 895 striped marlin, 874 sailfish, 171 spearfish, and 8 swordfish. The fishing area, number of angler days fished,

Table 1. Results of 1994 *Billfish Angler Survey*. Data in parentheses (-) are values recorded in 1993. Species codes are striped marlin (S), blue marlin (BLM), black marlin (BKM), and sailfish (SF).

	Angler Fishing Days	Billfish Per Fishing Day (CPUE)	Major Species
Pacific Ocean			
Hawaii	2,570 (3,259)	0.26 (0.33)	BLM
So. California	1,600 (1,456)	0.09 (0.10)	SM
Baja California, Mexico	1,103 (1,278)	0.77 (0.60)	SM
Guaymas, Mexico	34 (24)	0.56 (0.29)	SF
Mazatlan, Manzanillo, Mexico	85 (101)	0.67 (0.55)	SF
Puerto Vallarta, Mexico	46 (41)	1.33 (0.46)	SF
Acapulco, Ixtapa, Zihuatanejo, Mexico	103 (72)	2.01 (1.54)	SF
Guatemala	10 (101)	2.90 (2.89)	SF
Costa Rica	92 (117)	2.17 (1.80)	SF
Panama	67 (120)	2.93 (1.78)	SF
Japan	3 (826)	0.00 (0.05)	BLM
Columbia	64 (-)	0.13 (-)	SF
Guam, U.S.A.	7 (253)	0.14 (0.18)	BLM
Siapan, U.S.A.	250 (-)	0.12 (-)	BLM
Fiji	32 (13)	0.16 (0.23)	SF
Tahiti, French Polynesia	52 (34)	0.42 (0.38)	BLM
New Caledonia, Solomon Islands	12 (-)	0.17 (-)	BLM
Australia	164 (156)	0.56 (0.53)	BKM
New Zealand	32 (135)	0.19 (0.27)	BLM
Papua New Guinea	40 (46)	0.08 (0.22)	BLM
Malaysia	16 (-)	0 (-)	BLM
Hong Kong	28 (16)	0.14 (0.12)	BLM
Indian Ocean			
Kenya	62 (141)	0.40 (0.67)	SF
Mauritius	32 (225)	0.22 (0.22)	BLM
Mozambique	10 (-)	0.10 (-)	SF

catch of billfish per angler-day (CPUE), and major species are indicated. The catch rates for 1993 are shown in parenthesis.

Billfish Tagging -- The *Billfish Tagging Report* cards received in 1995 indicate 1,206 billfish were tagged and released, 54% more tags released than in 1994 (Table 2). Increased tagging of blue marlin and striped marlin were noted from Hawaii and Baja California and of striped marlin from southern California.

Table 2. Summary of all fish tagged in 1995.

Striped Marlin	617
Blue Marlin	318
Short-billed Spearfish	120
Broadbill Swordfish	73
Sailfish	71
Marlin	5
Yellowfin Tuna	8
Whitetip Shark	5
Bigeye Tuna	5
Shortfin Mako Shark	3
Black Marlin	3
White Marlin	2
Dorado	2
Long-billed Spearfish	1
Albacore Tuna	1
Hammerhead Shark	1
Total Releases	1,235

Twenty billfish tags were returned in 1995, five from blue marlin, twelve from striped marlin, one from swordfish, and one from sailfish. Tags from one bigeye tuna and one mako shark were also recovered. Of the blue marlin, all were tagged and recaptured near Hawaii. Most notable were two blue marlin, tagged near Kailua-Kona, which were at liberty for 706 and 559 days and traveled a net distance of 208 and 597 nautical miles, respectively. Two striped marlin tagged near San Clemente Island, California, were recovered 205 and 129 days later after traveling 2,737 and 1,506 nautical miles (respectively) toward Hawaii. The swordfish traveled the other direction. Tagged just east of Hawaii, it moved 1,852 nautical miles toward California in 610 days.

The success of both the *Survey and Tagging Program* is due to the cooperation of the anglers, fishing vessel captains, commercial fishers, and supporting agencies. Their support is sincerely appreciated. (D. Holts and D. Prescott, 619-546-7186)

47th International Tuna Conference Held

The 47th International Tuna Conference was hosted by the Pelagic Fisheries Resources Division at the University of California's Lake Arrowhead Conference Center, May 20-23, 1996. The conference was attended by 95 scientists and tuna industry leaders from the United States, Canada, Latin America, Japan, Australia, Europe, and the Asian Pacific. Division scientists Norm Bartoo, Alan Jackson, and Rand Rasmussen chaired the event.

The conference theme, "Sustaining Tuna Fisheries--Issues and Answers," was addressed by the authors of 36 oral presentations and 10 posters. Highlights included impressive developments in the automated monitoring of tuna movements, the direct estimation of age and growth of tunas, the understanding of the distributions of tunas relative to environmental features, and the determination of stock structure by DNA analysis.

Proceedings of the 47th Tuna Conference are available on the Internet at <http://swfsc.ucsd.edu/tunaconf.html>. The 48th International Tuna Conference will be hosted by the Inter-American Tropical Tuna Commission at the Lake Arrowhead Conference Center on May 20-22, 1997. (A. Jackson, 619-546-7048)

TIBURON LABORATORY

Tiburon, California

COASTAL FISH COMMUNITIES INVESTIGATION

Length and Age of Lingcod Landed in California and Oregon by Commercial Fishermen Analyzed

The management of lingcod (*Ophiodon elongatus*) has been impeded by uncertainty regarding fish length-at-age relationships. Since 1992, Fishery Biologists Kelly Silberberg and Tom

Laidig have analyzed length and age data from the commercial fisheries of California and Oregon. They determined the age of over 4,700 lingcod, based on examination of dorsal fin rays collected by the California Department of Fish and Game and the Oregon Department of Fish and Wildlife.

Female fish from California averaged 586 mm in length and 4.8 years in age, while females from Oregon averaged 610 mm and 5.0 years. The oldest female sampled off California was 13 years and off Oregon, the oldest was 17 years. Males averaged 551 mm at 5.0 years off California but 517 mm at 3.8 years off Oregon. By disregarding one sample of particularly small fish from Coos Bay, however, the average age of the Oregon fish was 5.3 years, which is close to the California average. The oldest male from both states was about the same age: 13 years from California and 14 years from Oregon.

Analysis of length-at-age data indicates females and males grow at similar rates in both states (Fig. 1 and 2). Analysis of frequency of occurrence at age showed that in both states the catch was dominated by females and males of generally the same age-groups; thus, three-, four- and five-year-old fish dominated in the California landings, whereas two-, three- and four-year-old fish dominated in the Oregon landings (Fig. 3 and 4).

Researchers believe there is cause for concern about the relatively young age of fish being harvested in both states. This will be a subject of analysis in next year's stock assessment. (K. Silberberg and T. Laidig, 415-435-3140)

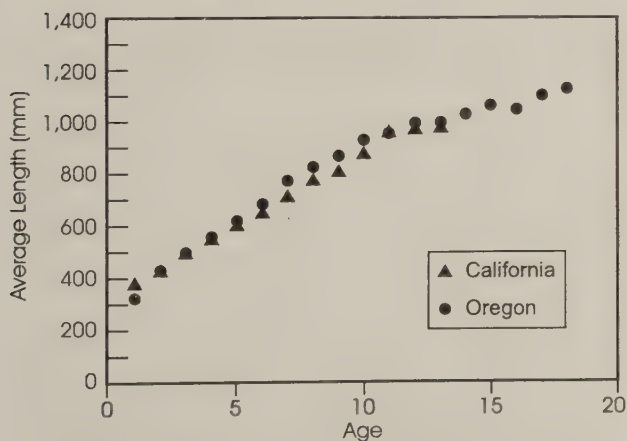


Figure 1. Average length at age for female lingcod.

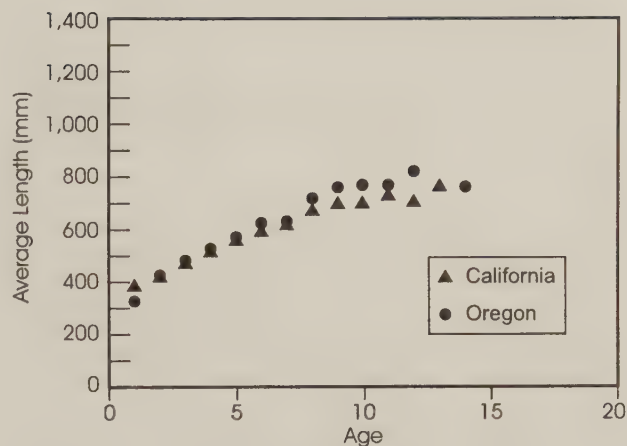


Figure 2. Average length at age for male lingcod.

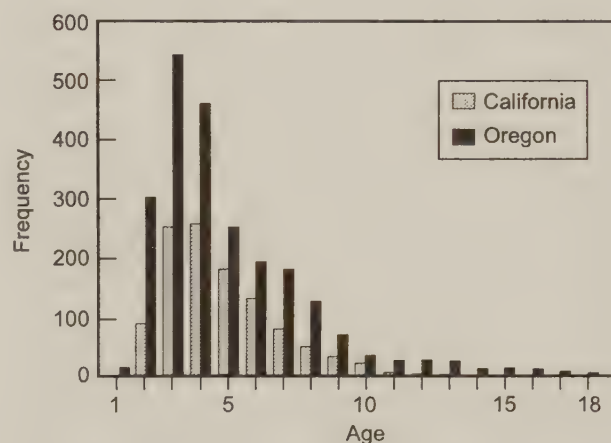


Figure 3. Frequency of occurrence at age for female lingcod.

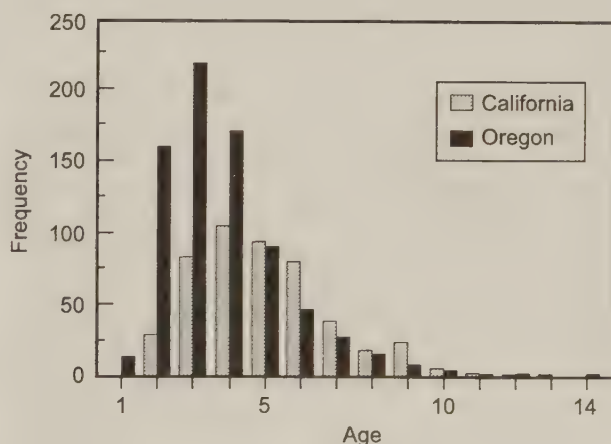


Figure 4. Frequency of occurrence at age for male lingcod.

GROUNDFISH ANALYSIS INVESTIGATION

Midwater Trawl Survey of Pelagic Juvenile Rockfishes Tracks Bocaccio Year-Class Strength

The Groundfish Analysis Investigation has conducted annual sea surveys designed to estimate the abundance of pelagic juvenile young-of-the-year (YOY) rockfish since 1983. Month-long cruises have been conducted aboard the NOAA research vessel *David Starr Jordan* along the central California coast during May-June, a period when YOY are most susceptible to capture by midwater trawl gear. Since the survey's inception, the working hypothesis has been that interannual differences in the abundance of pelagic juvenile YOY rockfish sampled during the midwater trawl survey reflect differences in future year-class strength of fish entering the commercial rockfish fisheries.

Previously, rigorous testing of this hypothesis was difficult because rockfish are slow-growing species that typically do not recruit to the exploited population at ages of 5 or more years. For example, the 1985 widow rockfish year-class did not appear in the commercial fishery until 1990, at which time it had only partially recruited. Moreover, given delays in the processing of otoliths and in summarizing catch data by state agencies, the most recent information available to assessment scientists is typically 2 years old. The combination of these two constraints has necessitated the development of a long time series in order to compare pelagic juvenile YOY abundance with time series of recruitment estimated from traditional stock assessments. Previous statistical work indicated that at least ten years of data were required before a sufficiently powerful test of the hypothesis could be made.

Bocaccio (*S. paucispinis*) is a species with a long history of exploitation in California. A stock assessment is now being prepared and a recruitment time series for bocaccio has been estimated from data sources exclusive of the midwater trawl survey (for example, trawl fishery catch-at-age data, length-frequency distributions from the trawl, set-net, hook-and-line, and recreational fisheries, a CalCOFI spawning biomass index, recreational catch per unit effort and the Alaska Fisheries Science Center triennial shelf survey). A comparison of this recruitment series with an index of bocaccio abundance in the midwater trawl survey shows good agreement between these two estimates of reproductive success (Fig. 5). Scientists can now use the latter series in

future stock assessments, to increase the accuracy and precision of population projections and yield recommendations. (S. Ralston 415-435-3149, ext. 229)

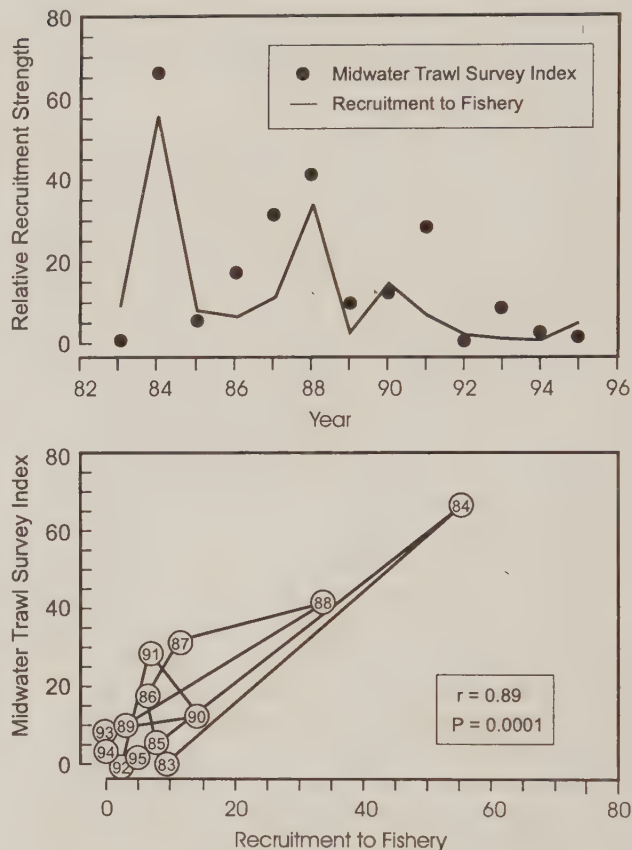


Figure 5. Relationship between the midwater trawl survey index of bocaccio abundance and year-class strength determined by recruitment to the fishery.

GROUNDFISH PHYSIOLOGICAL ECOLOGY INVESTIGATION

Growth and Endogenous Energy Utilization of Yellowtail Rockfish Early Life Stages

On the basis of a recently completed 10-year trawl and diving survey of pelagic and newly settled juvenile yellowtail rockfish, scientists concluded that recruitment variability and population regulation appeared to be based on factors that influence larval growth and survival. In previous work on quantitative and qualitative aspects of reproduction in yellowtail rockfish, Tiburon Laboratory researchers found that not only do the number of eggs produced by females (fecundity) vary by year and location, but the size and nutritional content of the eggs vary as well. The relative size and

thus the nutritional and energy content of eggs contribute to the survival and growth potential of larvae at the time of hatching, or in the case of *Sebastes* species, at parturition. In a previous quarterly report, preliminary results of a laboratory study of development of embryos and larvae taken from pregnant yellowtail rockfish were provided. In this report, summary findings are presented showing that endogenous energy is used in embryonic and larval growth during gestation.

Over a three-year period, a total of 21 gestating females were taken by hook-and-line from Cordell Bank, California, and transported live to the University of California Bodega Marine Laboratory. Fish were held in 2,000-liter circular tanks at ambient light and water conditions (average temperature of 11.96°C and salinity of 32.31 ppt) for the duration of the study. At approximate three-day intervals, fish were anesthetized and catheterized through the urogenital papilla to obtain specimens of eggs and larvae. From this laboratory population, the reproductive developmental process of three females was monitored from unfertilized eggs through embryogenesis, hatching, larval incubation, and parturition.

Scientists using these specimens had the opportunity to determine the rate at which the endogenous energy contained in the yolk and oil globule was consumed and assimilated into tissue. Specimens fixed in formalin at each stage of development were dissected into chorion, yolk, and tissue portions, dried at 100°C for 24 hours, and weighed in triplicates of 20 specimens to the nearest 0.0001mg. Estimates of the oil globule were obtained by subtraction of the combined yolk, tissue, and chorion weights from the total egg weight.

Gravimetric analyses of endogenous energy reserves (namely, yolk and oil globule) in embryos and larvae during gestation showed steep linear declines in yolk and a gradual linear decline in the oil globule. Conversely, tissue assimilation was continuous and linear (Fig. 6). The most rapid increase in growth occurred approximately 14 days after fertilization. This is when the embryonic axis is well formed and optic cups and otic vesicles are developed. At hatching (day 23), 40% of the yolk reserves and 26% of the oil globule reserves remained. By parturition, when larvae had incubated for approximately 6 days, only 14% of yolk and 8% of oil mass remained. These limited reserves at the time of larval release are indicative that newly released larvae have approximately 1-3 days to convert to exogenous feeding for continued growth and

survival. The overall conversion efficiency by weight from fertilization to parturition was 54%, a figure comparable to those found in other fishes during their endogenous feeding periods (40-70%).

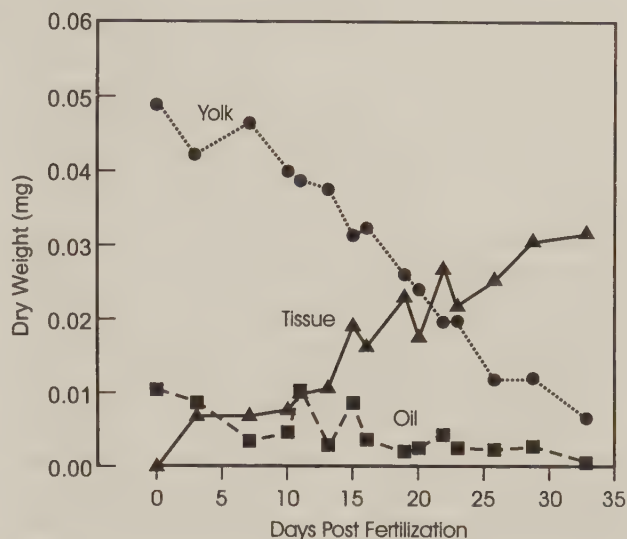


Figure 6. Dry weights of yolk, oil globule, and assimilated tissue in embryos and larvae of yellowtail rockfish during the 33-day gestation period.

While serving as a model for other rockfish species, the findings of this study, combined with those of field surveys, show that environmental conditions in and around the first few days of parturition can largely determine recruitment success. Close attention to these conditions could provide predictive capability and insight into the factors that influence larval growth and survival. (M. Eldridge, 415-435-3149)

INFORMATION TECHNOLOGY SERVICES

Workshops Focus on Networking and Use of the Internet

Information Technology Services Chief Rob Bistodeau was among those attending the NMFS headquarters-sponsored wide-area networking workshop in Silver Spring, Maryland, on June 24-25, 1996. NMFS networking specialists from all the regions and headquarters attended. The focus of the

workshop was on the future of the NMFS network. The current network configuration was reviewed, future requirements and solutions were identified, and budget constraints were considered. The outcome of the discussions will be presented to the National Information Management Board (NIMB) for decisions on the direction of the network in the next few years. Other issues discussed were the planned NMFS cc:Mail upgrade, status of the NOAA Mail Hub Project, router upgrade plans, various network operating systems, NOAA domain name change requirements, and the need for NMFS standards.

Most of the participants stayed on for the NOAA-sponsored second annual WEBShop on June 26-28. The three-day workshop included managerial presentations on the use of the World Wide Web and technical presentations on implementation of various types of web sites. The overall message of the workshop was that the World Wide Web is fundamentally changing the way NOAA does business. NOAA will increasingly use the World Wide Web for internal coordination and collaboration, for efficient information dissemination, and to promote the agency image. (R. Bistodeau, 619-546-7055)

PUBLICATIONS

Published

Boehlert, G. W. 1996. Biodiversity and the sustainability of marine fisheries. *Oceanography* 9(1):28-35.

Clapham, P. J., and R. L. Brownell, Jr. 1996. The potential for interspecific competition in baleen whales. *Rep. intl. Whal. Commn.* 46:361-367.

DeMartini, E. E. 1996. Sheltering and foraging substrate uses of the arc-eye hawkfish *Paracirrhites arcatus* (Pisces: Cirrhitidae). *Bull. Mar. Sci.* 58:826-837.

A combination of free-ranging snorkel surveys and focal-animal observations were used to evaluate substrate use by *Paracirrhites arcatus*, a typical cirrhitid recognized for its conspicuous "perching" and ambushing behavior. The arc-eye hawkfish used different substrates for sheltering and for foraging. *Pocillopora meandrina*, the only common species of closely branched coral in the main Hawaiian Islands, was the perch most frequently encountered (96% of all cases) on snorkel surveys at seven sites on the leeward side of the Island of Hawaii. *P. arcatus* sought refuge within *P. meandrina* whenever predators approached closely but darted out from coral heads to feed. Foraging strikes were directed mainly at targets on ben-

thic substrates surrounding *P. meandrina* refuges; strikes were primarily directed (81-96% of all strikes) at prey on rock/dead coral substrate that dominated cover (43-90%) at the study sites. *P. arcatus* also fed to a major extent within the near-bottom water column. The dichotomy between preferred foraging and sheltering substrates is discussed relative to the tradeoff between foraging benefit and risk of predation hazard when the two substrates differ.

DeMartini, E. E., and T. J. Donaldson. 1996. Color morph-habitat relations in the arc-eye hawkfish *Paracirrhites arcatus* (Pisces: Cirrhitidae). *Copeia* 1996(2):362-371.

The arc-eye hawkfish (*Paracirrhites arcatus*), like other congeners, has multiple color morphs whose relative abundances vary greatly among geographic locations. To gain insight into the environmental factors that potentially influence the morph distributions of this species, two series of surveys were conducted at complementary spatial scales. One extensive, broad-scale survey of 165 central, South, and western Pacific sites was conducted over a 9-yr period (1985-93). Another series of sites, located along an exposure gradient on the leeward coast of the Island of Hawai'i, was surveyed intensively during 1990-94. Surveys on both spatial scales revealed relative abundances of the species' two most common (white-striped, WS; melanistic, MEL) morph phenotypes were independent of microhabitat, body size, or adult sex. Morph frequencies were, however, related to bottom depth at both spatial scales. On the trans-Pacific scale, the WS morph was more common at depths 10 m over a depth range of 1 to 27 m. At the regional scale of Hawai'i, the MEL morph was rare at depths 8 m over a range of 1-12 m and relatively rare at 1-4 m depths wherever preferred branching corals (*Pocillopora meandrina*) were scarce. Morph distributions are discussed in terms of the relation between depth and the densities of preferred, branching coral perches at Hawai'i. Patterns are interpreted in terms of likely tradeoffs between intraspecific communication and predation risk at differing coral and fish densities.

DeMartini, E. E., F. A. Parrish, and D. M. Ellis. 1996. Barotrauma-associated regurgitation of food: implications for diet studies of Hawaiian pink snapper, *Pristipomoides filamentosus* (family Lutjanidae). *Fish. Bull., U.S.* 94:250-256.

Juvenile (128-244 mm fork length, FL) pink snapper (*Pristipomoides filamentosus*) were caught by hook and line from 60-90 m depths offshore of Kaneohe Bay, windward Oahu, Hawaii, during February-August 1994. About one-half of the 180 specimens were intercepted randomly by scuba divers 15-18 m below the sea surface and individually "bagged" before they were retrieved for the remaining distance to the surface. The other half were retrieved by fishing line to the surface ("unbagged"); these latter fish thus remained at continued risk of prey loss from regurgitation while stressed by the full extent of pressure change. The retained stomach contents of bagged and

unbagged fish were compared based on volume and type of food and on the size of individual prey items. Bagged samples of juvenile snapper on average retained a 116% (95% CI = 70-157%) greater volume of prey than unbagged snapper; bagged snapper also had more types and greater maximum body sizes of prey than did unbagged fish. These results are discussed in terms of designing quantitative diet studies for juvenile snapper and other deep-water physoclistous fishes.

DeMartini, E. E., F. A. Parrish, and J. D. Parrish. 1996. Interdecadal change in reef fish populations at French Frigate Shoals and Midway Atoll, Northwestern Hawaiian Islands: Statistical power in retrospect. *Bull. Mar. Sci.* 58:804-825.

Reef fish faunas were compared between surveys conducted more than a decade apart at each of two isolated and nearly pristine oceanic atolls (French Frigate Shoals and Midway Atoll) in the Northwestern Hawaiian Islands. Species composition, assemblage structure (density rankings), and population densities were compared to test the hypothesis that reef fishes had declined during a period of lower oceanic productivity in the central North Pacific. Within each of two principal habitats (barrier and patch reefs) at each atoll, species composition and rank densities differed little between sampling periods. Densities, however, generally declined by about one-third for many numerically dominant species and for taxa pooled into functional categories (trophic levels, feeding guilds). Patterns of temporal change were partly confounded by distributional shifts between barrier and patch reef habitats at French Frigate Shoals, perhaps reflecting indirect effects of storm disturbance on benthic algal habitat. Such effects, together with related changes in climate and oceanic productivity on an interdecadal time scale, might have been responsible for the apparent declines in reef fish densities at both atolls. Temporal patterns were clearer at Midway Atoll, where changes in benthic algae were not evident. The observations indicate that the statistical power necessary to detect changes in the population densities of reef fish species that exhibit large temporal fluctuations in numbers, particularly on oceanic islands, is generally low. Power to detect twofold changes may be adequate, however, if taxa are pooled into functional categories.

Johanos, T. C., and T. J. Ragen. 1996. The Hawaiian monk seal in the Northwestern Hawaiian Islands, 1994. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFSC-229, 111 p.

Kushima, J., S. Pooley, and A. Katekaru. 1996. Lobster rumble on the docks. *Hawaii Fishing News* 22(5):20-21.

Laidig, T. E., K. M. Sakuma, and M. Nishimoto. 1996. Description of pelagic larval and juvenile *Sebastes saxicola* (family Scorpaenidae), with an examination of larval growth. *Fish. Bull., U.S.* 94:289-299.

Pigmentation, morphometrics, head spination, fin development, and meristic characters were described and illustrated for the developmental series of larval and pelagic juvenile (4.7-38.2 mm standard length) stripetail rockfish (*Sebastes saxicola*). Pigment patterns were sufficiently distinct to differentiate larval and juvenile *S. saxicola* from other *Sebastes* species occurring in the study area (central California). Early larvae of *S. saxicola* were identified by the presence of pigment on the postanal ventral midline and the nape and by the lack of pigment on the lower jaw and the pectoral fins. Late larval *S. saxicola* had areas of intense pigment along the dorsal, lateral, and ventral midlines. Juvenile *S. saxicola* were identified by their distinctive bar pattern and meristic characters. Examination of otolith characters indicated that the extrusion check radius of *S. saxicola* differed from that of other *Sebastes* species examined. Otolith characters, used in combination with pigment patterns, readily separated larval *S. saxicola* from other *Sebastes* species. Calculated growth rates for *S. saxicola* were slower than most previously reported growth rates for other *Sebastes* species.

Perkins, P. C., and E. F. Edwards. 1996. A mixture model for estimating bycatch from data with many zero observations: Tuna discards in the eastern tropical Pacific Ocean. *Fish. Bull., U.S.* 94:330-340.

Prager, M. H. 1996. A simple model of the blue crab, *Callinectes sapidus*, spawning migration in Chesapeake Bay. *Bull. Mar. Sci.* 48(1):421-428.

The blue crab (*Callinectes sapidus*) supports large commercial and recreational fisheries along the southern and eastern coasts of the United States. Females of the Chesapeake Bay stock, the most important commercially, spawn in summer near the mouth of Chesapeake Bay. Estimates of crab population density on the spawning grounds, based on 18 cruises during the 1986 and 1987 spawning seasons, were published in 1990. In an attempt to put those estimates into a conceptual framework, a simple model of the blue crab spawning migration in Chesapeake Bay was developed. When fit to the data from 1986 and 1987, the model represented the within-year patterns of population density reasonably well. The model is based on a scaled normal probability function and requires estimation of only four parameters; these provide year-specific estimates of the female spawning stock size, the average residence time of a female on the spawning grounds, and two quantities related to migratory timing. For the two years examined, the estimates of spawning population size were strongly negatively correlated to the estimates of residence time, and each estimate had a high coefficient of variation. Thus, in the absence of external information about residence time, the model could not furnish precise estimates of the spawning-stock size. As a plausible working hypothesis, the mean residence times in 1986 and 1987 were assumed identical and between 4 and 21 days. Under this assumption, parameter estimates from the

model suggest an approximate 60% decline in spawning-stock size from 1986 to 1987.

Ralston, S., E. B. Brothers, D. A. Roberts, and K. M. Sakuma. 1996. Accuracy of age estimates for larval *Sebastes jordani*. Fish. Bull., U.S. 94:89-97.

Issues concerning the accuracy of larval age estimates for *Sebastes jordani* were examined. To localize a starting point for daily increment counts, gestating and planktonic larvae were examined to determine whether an extrusion check forms at parturition. The authors also assessed 1) the resolution limitations of optical microscopy in ageing larvae, 2) the precision of age estimates, and 3) the effect of specimen age on the reliability of ages. Preextrusion increments are commonly observed in gestating and planktonic larvae, but a distinctive extrusion check forms in the otolith at parturition. This feature occurs predictably at a radius of 15-19 μm and provides an unambiguous starting point for increment counts. Observations of larval otoliths with a scanning electron microscope revealed that the minimum size of postextrusion increments is 0.6 μm , which is large enough to be resolved with a high-quality optical system. Cross-checking of ages among three readers showed 84% agreement to within 1 d and no systematic differences among readers. The clarity of otolith microstructure resulted in high confidence scores for age estimates; however, very young larvae (0-3 d) were the most difficult to age. An exponential growth model fitted to 2,203 aged larvae indicated that during the first month of life, growth in length proceeds at the rate of $2.75\% \text{d}^{-1}$.

Taylor, B. L., and A. E. Dizon. 1996. The need to estimate power to link genetics and demography for conservation. Conserv. Biol. 2:661-664.

Approved by Science and Research Director, SWR

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He, X., C. H. Boggs, and K. A. Bigelow. Cluster analysis of longline sets and fishing strategies within the Hawaii-based fishery. For consideration for publication in Fisheries Research.

Lenarz, W. H., and F. R. Shaw. Estimates of tag loss from double-tagged sablefish, *Anoplopoma fimbria*. For consideration for publication in Fishery Bulletin, U.S.

MacCall, A. D. Patterns of low frequency variability in fish populations of the California Current. For consideration for publication in California Cooperative Oceanic Fisheries Investigation Report.

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Honolulu

DeMartini, E. E., and F. A. Parrish. 1996. A reevaluation of shallow reef fish populations at French Frigate Shoals and Midway Atoll in September 1995. SWFSC Admin. Rep., Honolulu, H-96-01, 20 p.

Herbst, L. H., and P. A. Klein. 1996. Analysis of tumorigenicity and differential gene expression in fibroblast cell lines derived from normal skin and fibropapillomas of the green turtle (*Chelonia mydas*). SWFSC Admin. Rep., Honolulu, H-96-04C, 19 p.

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